IN THE DRAWINGS:

Please CANCEL Figure 4.

Please enter substitute Figures 1 and 2 filed herewith.

REMARKS

In the outstanding Office action, claims 13-17 were pending. Claims 13-17 were rejected for indefiniteness and variously as being anticipated by or unpatentable over a reference to Yamagishi et al.

The Office Action has been most carefully studied. In this amendment applicant has amended claims 13-17 and has added new claims 14-22 more particularly pointing out the invention. The new and amended claims have been carefully written to avoid any questions under 35 U.S.C. §112, in accordance with the guidelines and requirements set forth in the outstanding Office Action. Accordingly, as will be discussed in detail below, it is believed that the application is clearly in condition for allowance.

Information Disclosure Statement

Copies of the references listed on applicant's IDS may be found in the files of parent applications 10/031,106 and 10/031,103. Accordingly, consideration of same and processing of applicant's IDS for printing of the information on the front of the patent are respectfully requested. (See MPEP 609 A (2) "Legible Copies".)

Drawings

In the drawings, Figure 4 has been canceled for consistency with the specification. In substitute Figure 1, drawing legends have been added to describe the elements objected to by the Examiner.

With regard to the objection as to lack of illustration of a controller with memory, applicant respectfully submits that such illustration does not appear to be necessary. As described in the specification at page 5, line 23 et seq., the element referenced 9 in Fig. 1 indicates a pulse generator that generates the sampling pulses, while a relay 10 actuates a switch 2 to switch the sampled signal value to the capacitor 3 that stores the sampled value till the next sampling cycle. The description of Fig. 1 explains that this circuit can

detect very slow changes of the sampled signal and the electronic states of the bistables 8a, 8b and 11a, 11b give indication whether the changes were positive or negative and whether they have been within the preset threshold limit or outside thereof. Such operation does not require the presence of a microcontroller although one could be employed, if desired.

Nor is it believed necessary to illustrate a means for repeatedly turn the battery charging current on and off. The claimed invention is a method for determining the end-of-charge moment. When this moment has been indicated, one can use a switch to stop the charging process, but the a key problem solved by the invention is to know exactly when the delicate optimal moment of the charging process has come, in which case the charging process can be terminated.

Specification

The specification has been reviewed and various inconsequential informalities have been corrected. In addition, minor amendments have been made to clarify the text.

A statement of invention, providing antecedent basis for the terminology employed in amended base claim 13, has been inserted on page 4 at line 15. Support for this statement may be found in claim 13 and elsewhere in the specification as filed including the incorporated applications. The insertion at page 9, line 18 servers to reinstate two paragraphs canceled in the Preliminary Amendment filed April 15, 2004, thereby providing additional support for claims relating to the determination of parameters other than voltage, e.g. current.

Claim Objections

Minor, inconsequential amendments have been made to the claims, without narrowing, to address the informalities kindly pointed out by the Examiner.

Claim Rejections - 35 USC §112

Claims 13-17 have also been amended, without narrowing, to address the several rejections based on allegedly indefinite language, to the extent believed appropriate.

Objection was raised to claim 13 in view of a statement on page 9 describing that "the circuit of Fig. 1 can determine the change of voltage signals only." However, as is clear from the context, this statement is applicable only to the one particular embodiment of the invention illustrated in the drawings. The invention includes many other embodiments, some of which are described in the specification, including methods of determining an end-of-charge moment for a battery by sampling the charging current. For example, the sentence following the phrase cited by the Office on page 9, mentions other characteristics can also form reasonable tasks (that may be addressed by the invention) including that of temperature or current. It is also explained in the paragraphs inserted on page 9, line 18, that other parameters, such as current, can easily be converted to a voltage signal, for example, by using a current-to-voltage converter whereby the apparatus of Fig. 1 can be used for these other signals, too.

Reference is also made to the paragraph added at page 4, line 15, in the preliminary amendment filed April 15, 2004, according to which describes monitoring of either the battery voltage or the charging current. Clearly, the invention is not limited to the sampling of the voltage parameter.

With regard to the objection to claim 14, it is respectfully pointed out that the threshold level, as now recited in the amended claims is a simple magnitude of the parameter change e.g. a change in the voltage or, if the charging current is monitored by a current-voltage converter, this can be a predetermined current step. No time dimension is required to define this change. The time dimension is dependent upon the sampling period, as is apparent from the specification.

Claim Rejections - 35 USC §102 Anticipation

With regard to the rejection of claim 13 for anticipation by Yamagishi '880, Yamagishi '880 discloses two different ways of checking a battery under charge, referenced "a" and "b" hereinbelow. The invention as now claimed in amended base claim 13 is clearly and patentably distinguished from both checking modes as will now be explained, addressing each mode in turn. The patentable distinctiveness of the claimed invention over Yamagishi can also be understood by considering the respective objects of the claimed invention and the reference.

It is an object of the claimed invention to prevent damage to a battery during charging by detecting the onset of a fully charged condition, enabling charging to be terminated before overcharging occurs. In contrast, Yamagishi is particularly concerned with protecting personnel by detecting battery abnormalities so that quick charging can be stopped before an abnormal battery becomes overheated with a consequent risk of explosion.

a) Yamagishi 's sampled battery voltage is compared with a preset reference voltage which is given a value about 20% higher than the maximum "fully charged" battery voltage as is determined by measurement. The preset reference voltage requires the previous knowledge of a maximum permitted voltage appropriate for a given battery or battery type. If this preset reference voltage is exceeded, the battery is clearly defective and cannot be used any more. The reference voltage is not measured and specific to the particular battery being checked, but is a predetermined or calculated value.

The invention claimed in amended base claim 13, requires that the sampled electrical value be compared with the immediately preceding sampled and stored value to determine the extent of change. The difference between the sampled value and the immediately preceding value is the "change in value". The claimed method determines whether the change in value is below a predetermined threshold level and

an end-of-charge signal is generated if it is. Thus, the claimed method can generate an end-of-charge signal when a decrease in the <u>rate of change</u> of the sampled battery voltage is detected. As claimed in dependent claim 16, the end-of-charge signal can be employed to terminate the charging process.

The claimed invention makes it possible to avoid charging the battery beyond a point where chemical damage may occur. By avoiding chemical damage, the claimed invention can provide an advantageous cycle life for the battery. Some useful embodiments of the invention enable the the battery voltage to be monitored so carefully that very small changes in the battery voltage, or other suitable parameter, for example, changes two or three orders of magnitude less than the actual voltage level, will be apparent. If these changes drop below a threshold, the charging process can be terminated.

Some batteries have charging voltage curves that have a maximum. The inventive method of claim 13 enables this maximum voltage to be avoided by detecting the slope of the curve before the maximum voltage is reached. If the slope decreases below a specified threshold, a signal is generated and the charging process can be terminated. A battery monitored by the method of the invention as claimed in claim 13 would not be expected to be subjected to a battery voltage remotely close to the "preset reference voltage" of Yamagishi , which is defined as being 20% higher than the maximum charge voltage for the battery.

b) Yamagishi refers in several places, e.g. column 3, lines 40-42 and column 4, lines 16-18, to "a -ΔV and/or temperature control system under which the charge is controlled". However, this control system is not further described. Without admission, applicant speculates that the cited -ΔV may be the difference between the detected battery voltage and the reference voltage which is typically 20% higher than the fully charged voltage, as is described at column 4, lines 38-41. Again, without admission, it

may be that the negative sign is intended to mean that the control system of Yamagishi is based on a voltage drop, i.e. $-\Delta V$. Alternatively, $-\Delta V$ could indicate the amount the detected battery voltage is below the reference voltage, or some other voltage difference. These uncertainties make it difficult for one skilled in the art to draw useful teachings from Yamagishi with respect to the $-\Delta V$ control system. Certainly, however, Yamagishi does not remotely suggest detecting a decline in the rate of change of the sampled battery voltage and generating an end-of-charge signal when the decline is detected.

In the invention as now claimed in claim 13, the sign of the voltage change is not material. The claimed method calls for a response, namely generation of an end-of-charge signal, if the magnitude of the changed value is smaller than the predetermined threshold level for the change. In contrast thereto, in Fig. 2 of Yamagishi, at step 3, there appears a question concerning the $-\Delta V$ value which reads: "Has the $-\Delta V$ been detected?" According to Fig., 2 and the accompanying description, if the answer is "yes", then the charging is complete, step 7. If not, charging is continued. Thus the computer stops charging when the (predetermined) peak value of 15 V… has been detected." (column 4, lines 50-52) and other specified criteria are met. Such logic does not remotely suggest the method of the invention as now claimed in claim 13 wherein regardless of the sign of the detected change, an end-of-charge signal is generated when the sensed change between a sequential pair of discrete samples drops *below* a predetermined threshold.

Yamagishi provides little teaching regarding the $-\Delta V$ regulation, beyond mentioning that the charge is terminated once $-\Delta V$ reaches a desired value and charging is continued if the desired value of $-\Delta V$ is not detected.

Furthermore, during a normal battery charging process, the battery voltage steadily increases until, when it is close to a maximum normal value indicative of a fully

charged state, (if the battery is normal and such a maximum exists), then the rate of increase declines. This information is not provided by Yamagishi or any other art of record. The invention claimed in claim 13 can effectively detect such flattening of the voltage (or current) curve and generate the end-of charge signal which can be used to switch the charging process off before the peak voltage is reached or exceeded, thereby avoiding damage which can occur from overcharging a normal battery and also avoiding significant charging of an abnormal battery, which is potentially hazardous.

It is believed clear from the foregoing discussion that nothing in Yamagishi provides support for the assertion that method steps of claim 13, in its amended form, would be met by normal operation of the disclosed apparatus. Accordingly, base claim 13 is believed clearly distinguished from Yamagishi.

Claim Rejections - 35 USC §103 Obviousness

With regard to the rejection of claims 14-17 as being allegedly unpatentable over Yamagishi, as explained above Yamagishi's objective is quite different from that of the presently claimed invention. Yamagishi compares the detected battery voltage with a "preset reference voltage" to screen defective batteries. In contrast, the claimed invention compares consecutive samples to generate an end-of-charge signal for normal batteries and aims to avoid chemical damage. In contrast, Yamagishi's voltage comparison aims to identify abnormal batteries, i.e. batteries which have already suffered chemical damage. Clearly, Yamagishi does not remotely suggest applicant's invention as claimed in base claim 13.

It is the inventor's belief that the less damage is done to the battery during the charging process, the more the possibility of overcharging can be avoided. The inventor has determined that the "charged state" of the battery can be correlated with the phenomenon of the steepness of the changing battery voltage or battery current dropping below a certain level. A battery can be expected to have an extended life if the

charging process is terminated as soon as this charged state has been reached. To this end the inventor has devised a novel circuit which can be employed in the claimed method by means of which very small changes can be detected. That invention was protected in the parent application, now U.S. Patent Number 6,628,125. Other suitably sensitive circuits capable of detecting the flattening of the voltage or current curve will be apparent to those skilled in the art or will become apparent as the art develops. Prior to the present invention, no one has arrived at a solution, in which a correlation between the lifetime of a secondary battery and the very accurate prevention of any overcharging had been made. Yamagishi has not made such a correlation certainly.

Claims 14-23 depend from base claim 13 and are accordingly believed patentable for the reasons that claim 13 is patentable, and furthermore for the additional subject matter each claim recites.

Thus, claim 14 recites that the threshold level for the change in value of the battery voltage is 1 mV or less. The choice of 1 mV is not a mere optimum or preferred value that would be readily apparent to those skilled in the art, but is a remarkably small increment, indicative of surprising sensitivity in the claimed method. For example, if a battery has a charged voltage of about 1.5 V, then 1 mV is less than 1000 times smaller than the peak voltage. If the battery is a battery pack such as taught by Yamagishi , then 1 mV is 1/10,000 smaller than the measurable battery voltage.

The 1 mV threshold provides a surprisingly effective approach, by which the cycle lifetime of a battery may be significantly increased. This is not a foreseeable optimum, and is not foreshadowed in any of the prior art. Furthermore, a sensitivity of less than 1 mV is a unique property of the circuit of Fig. 1 and such a sensitivity cannot be economically attained in other ways. Normally a DC voltage or current has a fluctuation or drift which makes it difficult to detect very small changes.

As explained in the specification, the rate of voltage increase or decrease that triggers the end-of-charge signal can be varied for a given predetermined threshold by varying the sampling interval. The specification explains that for fast chargers, where the quickness of the charge is possibly more important than the completeness of the charge, shorter sampling periods can be employed. On the other hand, with longer sampling periods, noises and fluctuations may interfere with the sampling and the reaction time of the method will be slower. Claims 15 and 17 are directed to these features. Claim 16 defines a statistical method of determining the end-of-charge moment. Claim 18 claims a noise reduction technique. Claim 19 uses the end-of-charge signal to terminate the battery charging process and Claim 20 effects the termination before or when the fully charged state is reached. It will be understood that sensitive embodiments of the invention can enable charging to be continued until very close to the fully charge state, without exceeding it and perhaps damaging the battery. New dependent claim 22 specifies a uniquely useful sampling duration while claim 23 combines several of the foregoing dependent claim features with additional features.

Having regard to their respective additional features, and to the patentability of Claim 13, as explained above, the subject matter of none of dependent claims 14-21 is remotely suggested by the art of record whether considered individually or in combination, and the dependent claims are accordingly believed clearly patentable.

In view of the above amendments and the discussion relating thereto, it is respectfully submitted that the instant application, as amended, is in condition for allowance. Such action is most earnestly solicited. If for any reason the Examiner feels that consultation with Applicant's representative would be helpful in the advancement of the prosecution, they are invited to call the telephone number below for an interview.

Respectfully submitted,

By: ______________________________
Anthony H. Handal
Reg. No. 26,275 Ph: (212) 536-4870
Roger Pitt
Reg. No. 46,996 Ph: (212) 536-4867

KIRKPATRICK & LOCKHART LLP
599 Lexington Avenue (32nd Floor)
New York, NY 10022-6030

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope, postage prepaid, addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on ~~October 7, 2004.~~ November 2, 2004.

____
Anthony H. Handal
Reg. No. 26,275
Roger Pitt
Reg. No. 46,996